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09/865,393 PTO-892

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(12)(19)(CA) **Demande-Application**

(21)(A1) **2,287,844**

(22) 1999/11/01
(43) 2001/05/01

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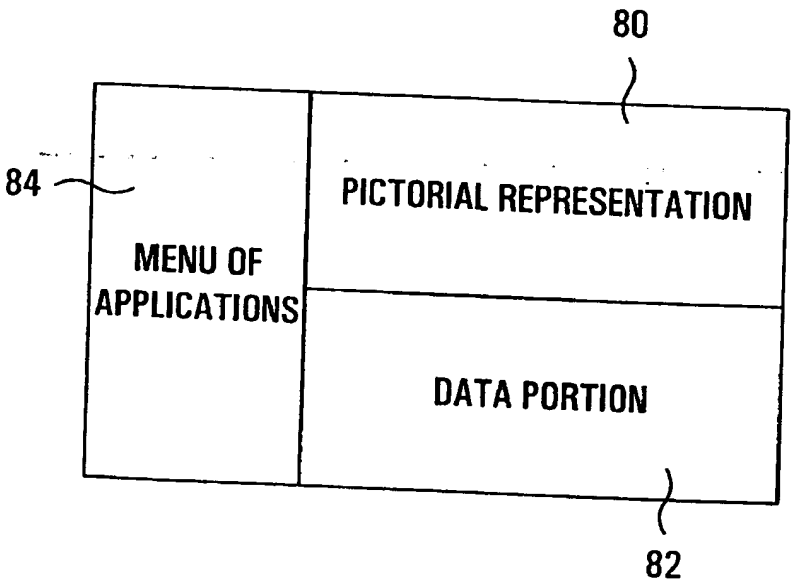
(51) Int.Cl.[7] H04L 12/26

(54) METHODE ET APPAREILLAGE POUR FOURNIR DE L'INFORMATION SUR LES PERFORMANCES D'UN RESEAU DE COMMUNICATIONS

(54) METHOD AND APPARATUS FOR PROVIDING INFORMATION ABOUT THE PERFORMANCE OF A COMMUNICATIONS NETWORK



(57) A method and apparatus for providing information about the performance of a communications network is described and claimed. The apparatus involves memory for storing a pictorial representation of the communications network. It further includes a receiver for receiving data relating to the network. A processor produces a composite representation including a graphical representation of the pictorial representation and a data representation for displaying at least some of the data relating to the network received by the receiver. The composite representation is available for use by a device to simultaneously display the pictorial representation and the data representation.

ABSTRACT

A method and apparatus for providing information about the performance of a communications network is described and claimed. The apparatus involves memory for storing a pictorial representation of the communications network. It further includes a receiver for receiving data relating to the network. A processor produces a composite representation including a graphical representation of the pictorial representation and a data representation for displaying at least some of the data relating to the network received by the receiver. The composite representation is available for use by a device to simultaneously display the pictorial representation and the data representation.

METHOD AND APPARATUS FOR PROVIDING INFORMATION ABOUT THE PERFORMANCE OF A COMMUNICATIONS NETWORK

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to network management and more particularly to providing information about the performance of a communications network and presenting it in a manner which is easily and quickly understood by a user.

Description of Related Art

Business enterprises that use distributed communications services often employ their own equipment at their own locations and lease telecommunications services from a telecommunications carrier or network services from an internet services provider (ISP) to provide for communication between respective locations. Systems which provide this functionality are commonly referred to as Virtual Private Networks (VPN). Generally, a VPN is defined as a point to point non-dedicated communication service.

Different parts of a VPN may be owned by the enterprise and a carrier, or ISP. In prior art systems, usually the carrier produces fixed format reports on an asynchronous basis to keep the enterprise aware of the status and performance of the VPN. Such reports are typically provided in a format selected by the carrier and are not readily customizable. Carriers usually charge fees for customization of reports. Furthermore, enterprises are often skeptical of data provided by the carrier, especially if it is provided a month or so after it was recorded.

Even with customization of reports, monitorable network parameters are provided by the carrier and little information, if any, about the enterprise is provided. Hence, such reports tend to be limited. Consequently, when a problem occurs, it can be difficult to determine whether the fault is at the

carrier or at the enterprise and therefore problem blame or responsibility can be difficult to assign. This can result in delaying a solution to the problem while the parties argue over who is responsible, as neither wants to commit resources to problem resolution if it is not their problem. To users of the VPN, services are delayed.

When a problem does arise, it may go undetected by the carrier or enterprise, however, customers of the enterprise may experience degradation in network performance. Thus, customers may become aware of a problem before it is discovered by the parties providing the network services. The problem may not be known to the carrier or enterprise until a customer reports the problem or until it appears in one of the fixed reports produced by the carrier. This also results in delayed problem detection, delayed allocation of responsibility and delayed resolution of the problem.

Even after problem responsibility has been assigned, prior art practice is often to review network performance reports to determine service agreement violations to determine who is responsible to pay any penalties and what penalties are to be applied. This is a tedious task involving reviewing reports, which may be several pages long, to determine service agreement violations and reviewing complex legal agreements to determine penalties associated with such violations. This can delay penalty payments.

In view of the above, the inventors of the present invention have recognized a need for a network management tool to allow an enterprise to remotely view and interact with a VPN and more particularly to view and interact with relevant portions of the carrier's or ISP's network on which the VPN is running, to obtain real time data for real time analysis of network performance. The present invention addresses this need.

SUMMARY OF THE INVENTION

The present invention addresses the above need by providing a method, apparatus and computer readable media for providing instructions for

directing a programmable device to provide information about the performance of a network in real time, thereby enabling real time analysis of network data and real time monitoring of network performance.

In one embodiment, this is achieved by producing a composite representation for causing a display to show both a pictorial representation of the communications network and a representation of data received in real time from the network. The composite representation may be transmitted for remote display purposes or may be used to control a display locally for local display of the composite representation. Preferably, received data is included in the composite representation in such a manner that the data will be shown in an area separate from the pictorial representation on the display. The composite representation preferably includes a menu of applications selectable by the user, such applications being responsible for obtaining and formatting the data in the composite representation for display in an easily readable manner and for providing access to a database for stored data associated with the network, through icons, for example. In general the applications provide for problem notification, performance monitoring and troubleshooting, event tracking and notification and service level agreement compliance monitoring and violation reporting.

The present invention provides a way of providing network data relating to both the carrier and the enterprise in real time and allows a user to select data important to the user for monitoring, to determine the performance of the network. In addition, it provides immediate notification of the entity responsible for a problem, resulting in faster mobilization of appropriate repair personnel, to locate and repair the problem and to allow the network to resume normal operation. In addition, real time monitoring of operator selectable network parameters allows network administrators to adjust the network for optimum performance, in real time. The present invention also correlates problems to service level agreement violations allowing real time notification of such violations and indications of penalties associated with such violations.

Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

In drawings which illustrate embodiments of the invention,

Figure **1** is a schematic representation of a virtual private network, according to a first embodiment of the invention.

Figure **2** is a block diagram of a data server, according to the first embodiment of the invention.

Figure **3** is a schematic representation of the transformation of data into a display representation, according to the first embodiment of the invention.

Figure **4** is a schematic representation of a page as displayed in response to a composite representation produced by the apparatus shown in Figure **2**.

Figure **5** is a schematic representation of modules stored in a main memory of the data server shown in Figure **2**.

Figure **6** is a pictorial representation of the communications network as seen in a pictorial representation display window of the page shown in Figure **4**.

Figure **7** is a tabular representation of data shown in a data portion of the page shown in Figure **4**.

Figure **8** is a schematic representation of a performance criteria query template which is shown in the data portion of the page shown in Figure **4**.

Figure **9** is a schematic representation of a performance data summary displayed in the data portion of the page shown in Figure **4**.

Figure **10** is a schematic representation of a correlated data display which would be seen in the data portion of the page shown in Figure **4**.

Figure **11** is a schematic representation of a display of bandwidth allocation for a plurality of applications running to/from a termination equipment on the network, as would be seen in the data portion of the page shown in Figure **4**.

Figure **12** is a schematic representation of customizable monitored network events as would be seen in the data portion of the page shown in Figure **4**.

Figures **13A** and **13B** are first and second halves of a schematic representation of an input template for receiving user input for selecting parameters to be tracked and used to notify an operator, as would be seen in the data portion of the page shown in Figure **4**.

Figure **14** is a schematic representation of a display template showing summarized service level agreements (SLA) relating to the network shown in Figure **1**, as would be seen in the data portion of the page shown in Figure **4**.

Figure **15** is a schematic representation of specific SLA agreement details, for one termination equipment as would be seen in the data portion of the page shown in Figure **4**.

DETAILED DESCRIPTION

As shown in Figure **1**, a virtual private communications network for a fictional enterprise customer is shown generally at **10**. The customer has a plurality of locations, each having respective termination equipment **12, 14, 16, 18, 20** and **22** respectively. A termination equipment may be a Centrex system, for

example, at a location for distributing telephone calls to callers and for distributing data to computers at or associated with the location.

In this embodiment, the virtual private network further includes a carrier network **24** provided by a fictitious telecommunications company. Alternatively, the carrier network **24** may be supplied by an internet services provider. The carrier network **24** in the embodiment shown, or alternative network supplied by an internet services provider, provide for communications to be transmitted from termination equipment **12-22** to any other termination equipment.

Still referring to Figure **1**, each of the termination equipment **12-22** includes a computer running a first data gathering program for monitoring various performance parameters reflecting how well information is being transmitted to and from the carrier network **24**. Each termination equipment **12-22** also includes a database **26** at the termination equipment, although the databases **26** may alternatively be at locations remote from their respective termination equipment. Each first data gathering program collects data in real time and stores such data in the database **26** at the termination equipment. In addition, the carrier network **24** includes a computer running a second data gathering program which monitors data transmissions between respective locations and stores data representing the performance of the carrier network in a carrier network database **28** stored at an administration location of the carrier network, or remotely.

In this embodiment, administration functions for the customer are carried out at a centralized Information Technology IT department location or at an IT department location associated with termination equipment **16**, for example. Termination equipment **16** is configured with a data server **30** operable to communicate with respective termination equipment **12-22** to access their respective equipment databases **26** to obtain network data gathered by respective first data gathering programs. In addition, the data server **30** is operable to communicate with the carrier network **24** to access the carrier

network database **28** to obtain data gathered by the second data gathering program at the carrier.

Referring to Figure **2**, the IT department data server is shown generally at **30** and includes a processor **32** operable to communicate with a bus **34** and main memory **36** through a host PCI cache/bridge **38**. In this specification, the word "processor" is used to include any programmable device or any circuit or combination of circuits capable of performing the functions described herein. In this embodiment the processor **32** includes a single microprocessor located at the data server **30**. Alternatively, however, the processor **32** may include a microprocessor remote from the data server, or a combination of one or more microprocessors at the data server and one or more microprocessors remote therefrom, for example. Or, the processor **32** may include one or more microcontrollers, other integrated circuits, or logic gate arrays, for example. Other such variations will be appreciated by one of ordinary skill in the art upon reading this specification and are not considered to depart from the scope of the present invention.

The bus **34** enables the processor **32** to communicate with a LAN adapter **40** for connection to other equipment at that location or at least associated with the termination equipment **16**, and to enable the processor to communicate with a small computer systems interface (SCSI) host bus adapter **42** for enabling communications with a disc drive **44**, a tape drive **46** and a CD ROM drive **48**. The processor **32** executes routines stored in the main memory **36** for controlling the SCSI host bus adapter **42** to receive programs or program modules from various computer readable media including a diskette **50** inserted into the disc drive **44**, a CD ROM **52** inserted into the CD ROM drive **48** or a tape **54** inserted into the tape drive **46**, for example. Alternatively, or in addition the computer readable media may include a local area network accessible through the LAN adapter **40**, for example.

The bus **34** further enables the processor **32** to communicate with an expansion bus interface **60**, a graphics adapter **62** and an audio/video adapter

64. The graphics adapter 62 and the audio/video adapter 64 are connected to a display 66 for displaying graphics and information according to program modules stored in the main memory 36.

The expansion bus interface 60 further allows the processor 32 to communicate with a keyboard and mouse adapter 68, a modem 70 and a temporary memory 72. The modem 70 facilitates communication between the processor 32 and the carrier network 24 shown in Figure 1 and provides access to yet another computer readable medium, which may be a server or a remote computer, for example, from which data and/or programs or program modules may be downloaded for storage in the main memory 36.

Referring to Figures 2 and 3, the processor 32 of the IT department data server 30 is programmed by codes stored in the main memory 36 to receive data from respective data servers at respective termination equipment 12-22 shown in Figure 1. Preferably, such data is received through the modem 70 and stored in temporary memory 72. The codes stored in the main memory for directing the processor to do this may be received from codes on diskette 50, tape 54, or CD ROM 52 or codes received via LAN adapter 40 or via modem 70, for example.

Similarly, the processor 32 is programmed by codes in the main memory (which may be received as described above) to receive data from the carrier network database 28 shown in Figure 1, for storage in the temporary memory 72. Further codes in the main memory 36 program the processor 32 to produce a composite representation which may be a hypertext mark-up language (HTML) page file, for example, for interacting with a browser run by the processor 32 to control the audio/video adapter 64 to cause the display 66 to produce a display image as shown in Figure 4, in response to the composite representation. In general, the composite representation may be any composite representation recognizable by a display program or display program module for producing a display image of the type described herein. Such composite representations are preferably web-enabled to provide any

time, anywhere, any platform usage of the display image. This can be done with a web-page or web application which could be written in JAVA, Javascript, XML, or HTML, for example.

Referring to Figure **4**, the display image includes a pictorial representation **80** and a data portion **82** and preferably includes a menu **84** of network management applications for selecting different data representations to appear in the data portion **82**. Each of these may appear in separate windows, or "frames" on a display screen. In effect, therefore, referring back to Figure **2**, the IT data server **30** produces a graphical representation for producing a pictorial representation of the data network, it receives data relating to the network, it produces a data representation for displaying at least some of the received data and it produces a composite representation including both the graphical representation and the data representation, the composite representation permitting simultaneous display of the pictorial representation and at least some of the received data. In the embodiment shown, it also includes a presentation of a menu in the composite representation.

Referring to Figures **2** and **5**, the organization of the main memory **36** is shown. The main memory includes locations for storing an overview module **90**, a navigational module **92**, a network summary module **94** and application modules, including an event viewer module **96**, a performance module **98**, a service level agreement (SLA) monitor module **100**, a notifications module **102**, a net simulator module **104**, an expert system module **106** and an area **108** for storing further applications.

Overview Module

In this embodiment, the overview module **90** contains program codes for directing the processor **32** to produce a composite representation for producing a generic display of the type shown in Figure **4**. The navigation module **92** programs the processor **32** to include within the composite representation a display representation for displaying the menu of applications

84 shown in Figure 4 and to receive user input through the keyboard and mouse adapter 68 to allow a user to navigate through different application modules 96-104. The applications modules 96-104 each program the processor 32 to gather data from the temporary memory 72 holding data received from respective termination equipment 12-22 and the carrier network 24 shown in Figure 1 and to produce data representations for inclusion in the composite representation for display in the data portion 82 produced by the overview module 90.

As shown in Figure 6, the pictorial representation produced by the composite representation is shown generally at 80 and includes a circular object 110, for example having a predefined, but programmable, set of attributes including color. For example, the object 110 may be shown in grey, red, orange, blue or yellow in this embodiment to indicate proper functioning and problems associated respective with network equipment associated with the object 110. Red would be used to indicate that the service has been interrupted, for example.

Similarly, the pictorial representation includes a plurality of rectangular objects, only one of which is labeled 112, which also have respective display attributes including colors such as grey, red, orange, blue and yellow for indicating functionality of the associated object. Each of the rectangular objects 112 depicts corresponding termination equipment. In this embodiment the object labeled 112 represents termination equipment 14 shown in Figure 1.

In addition, the pictorial representation 80 includes links, only one of which is labeled 114, connecting the rectangular objects to the circular object 110. Each of these links 114 also has associated display attributes, which in this embodiment may be one of the above indicated colors for indicating functionality of the associated link.

Under the control of the overview module 90 shown in Figure 5, the processor 32 shown in Figure 2 is directed to consider the data stored in temporary

memory **72** and compare it against known parameters which may be preset or stored in the temporary memory **72** by the user, through a configuration program (not shown) stored in the main memory **36** and operable to execute on the processor **32**.

Referring to Figures **2** and **6**, assuming the real time data stored in the memory **72** meets the criteria of the pre-stored parameters, each of the links **114**, the circular object **110** and the rectangular objects **112** is shown in grey to indicate that the carrier network, links and regional termination equipment is fully operative or functioning within acceptable performance limits. If, however, data relating to the performance of any of the links **114** do not meet the pre-stored criteria, the corresponding link is shown with a different color attribute to cause the link to appear in blue, red, orange or yellow, for example. Similarly, if any of the data associated with a particular region fails to meet the pre-stored criteria, the corresponding rectangular object **112** is shown with a color attribute, depending upon the type of problem. Similarly, if the data associated with the carrier network does not meet the predefined criteria, the circular object **110** associated with the carrier network is shown with a color attribute depending upon the type of problem. In this manner problematic network components are shown in color and thus are distinguished from functioning network components, which are shown in grey, to provide real time information about the functioning, or performance of the network. Colored components may also be accompanied by an icon or shape alterations for redundant indication of a problem to allow for colorblindness, poor lighting or poor display quality, for example.

The overview module **90** further includes codes for directing the processor **32** to present icons on the pictorial representation **80**, one of which is shown at **116**. The icon is preferably configured to provide a pictorial representation of a type of performance degradation being experienced by the object with which it is associated. In cooperation with a browser running at the processor **32**, the user can click on the icon **116** to obtain more information relating to the problem causing performance degradation as the icon **116** is hyperlinked to a

display module (not shown) which presents the data stored in memory **72**, representative of the error.

In addition, each rectangular object **112** is associated with hyperlinks to further information associated with the associated region such as a further geographical breakdown of the region, by city for example. In the embodiment shown the rectangular object **118** associated with region **4** for example shows hyperlinks **120**, **122** and **124** to data stored in either main memory **36** or temporary memory **72** associated with respective cities. The overview module may further place indicia such as shown at **126** adjacent corresponding city hyperlinks to indicate that further information relating to equipment associated with the city is available. In particular, this may be used to show an equipment or service inventory associated with the city, for example. A hyperlink accessible from this indicia **126** directs the user to an appropriate location in the main memory **36** or temporary memory **72** to provide such further information.

Event Viewer Module

As shown in Figure **7**, an example of a data display produced by a data representation produced by the event viewer module **96**, according to this embodiment of the invention, is shown generally at **130**. The data display **130** includes a row/column format for providing an IT professional with details regarding problems, such as the geographical location of the problem, circuit ID, network service affected, relative performance metric, applications impacted by the problem, responsibility designation, IP department contact person, log time of the problem, estimated time to repair and service level agreement indicator. Alternatively, different fields may be pre-defined for display. The data to fill the fields may come from the temporary memory **72** or the main memory **36**, or alternatively may be obtained through the modem **70** or LAN adapter **40** or any of the devices communicating through the SCSI adapter **42**.

Performance Module

Figure **8** shows a performance criteria display **132** produced from a data representation produced by the performance module **98**. In cooperation with the browser, a user may enter input for querying the data stored in the temporary memory **72** to cause the performance module to produce a representation for displaying real time or historical performance of at least one component of the network. In particular, a user may specify data to initiate a query of the data in the temporary memory **72** based on specific performance metrics between specific geographical locations of the VPN. Alternatively, the user may initiate performance queries on the basis of services running over the VPN, such as an ATM or frame relay service for example, or on the basis of the applications running over the VPN such as email and file transfer protocol (FTP) applications, for example.

After receiving the relevant query, the performance module **98** produces a representation for producing a display, an example of which is shown at **134** in Figure **9** wherein a summary of FTP parameters is shown, including errors, latency, utilization discards, bit rate, VPN used and total FTP sources in use. Those parameters may have been previously calculated at a carrier computer and/or a customer computer, or may be calculated at the IT department computer **30** from raw data supplied by the aforementioned customer database **26** and/or carrier network database **28**. Other parameters may alternatively or additionally be shown.

In addition, the display includes an icon **136** for indicating to a user that the rules-based performance analysis expert system module **106** stored in the main memory is available for correlating network performance data and for producing a representation for displaying such correlated data. The icon cooperates with the browser to invoke the expert system module **106** to permit the expert system module to generate data from raw data received from the customer databases **26** and/or carrier network database **28** to enable the processor **32** to produce a representation for producing a graphical

display, an example of which is shown at **138** in Figure **10**, for displaying the correlated data.

In addition, the performance module **98** includes instructions for directing the processor **32** to determine, from raw data obtained from the customer database **26** and/or the carrier network database **28**, bandwidth allocation associated with at least one application running on the network and for directing the processor to produce a representation of the bandwidth allocation to produce a display of bandwidth allocation as shown at **140** in Figure **11**. In the embodiment shown, the display of bandwidth allocation shows bandwidth allocation for a plurality of applications running to/from a termination equipment the carrier network and provides a graphical display of bandwidth allocated to each application thereby showing relationships between bandwidth allocation of various applications. In this embodiment, the performance module **98** further includes instructions for similarly causing predicted and observed bandwidth allocation to be graphically displayed.

Notifications Module

The notifications module **102** includes codes for directing the processor **32** to monitor network events determined from raw data from the customer databases **26** and/or the carrier network database **28** and produce a representation for displaying at least one monitored network event, and preferably a plurality of monitored network events. A display produced by such representation is shown generally at **142** in Figure **12**. The performance module provides the capability to automatically monitor or track specific VPN events specified by an operator such as outages, performance parameters, and allocation bandwidth usage, for example. When a customer defined event has been detected, the customer can configure the system to automatically notify a specific individual or individuals via a number of different notification methods, such as a pager or email, of the occurrence of the event.

In this embodiment the notifications module allows the customer to monitor the occurrence of three kinds of events on the VPN: outages, performance

threshold violations, and application bandwidth usage violations. Outage monitoring provides the capability to monitor for loss of communication between any node of the VPN and the VPN itself. Performance monitoring provides the capability to set performance thresholds for any performance metric on the VPN and monitor these thresholds for violation. Application bandwidth usage monitoring provides the capability to set VPN bandwidth allocation thresholds for any application running at one termination equipment on the VPN and monitor these thresholds for violation.

In this embodiment the representation produced by the notifications module **102** produces a tab-based user interface that provides the user access to the three event categories for tracking and notification. Each tab is associated with a list of current events that have been configured for monitoring and notification. For application based events, the list includes five fields, including an application field **144** indicating the type of application being monitored, a percent of VPN field **146** showing the VPN bandwidth threshold in percentage terms (above which a notification will be triggered), a time of alert field **148** indicating the time delay before notification of threshold violation is sent out, a site field **150** indicating the VPN tributary being monitored, and a notification type field **152** indicating the type of notification to be used. In conjunction with the browser, users can remove items from the list by pressing a delete from list button **154** in the bottom righthand corner of the window. Configuring an application for bandwidth usage tracking and notification is done by selecting an edit list button **156** in the bottom righthand corner of the window.

Pressing the edit list button **156** expands the application window to allow the user to enter the appropriate information for monitoring bandwidth usage of a specific application, as shown at **180** in Figure **13**. As an illustrative example, video application tracking and notification for the occurrence of excessive usage of the video application can be configured using this display. To do this, a location where the video application is to be monitored is entered in the notification settings for location field **182**. The application to be monitored is

identified by selecting a video button **184** from among a plurality of select application buttons **185**. The VPN bandwidth threshold is set at **35%** using a pulldown menu bar **186**. Finally, the user identifies the time of alert and notification type using the pulldown menu bars **187** and **188**. When all this information is entered an add to list button **189** is pressed and the new application event to be tracked is added to the list. In this manner the user can configure the system to monitor video traffic such that whenever video traffic exceeds **35%** of the allowable traffic in the monitored tributary, the user who configured the event tracking is notified according to the parameters entered.

SLA Monitor Module

Finally, the SLA monitor module **100** includes codes for directing the processor **32** to produce a representation for causing a display as shown at **190** in Figure **14** enabling a user to select which of a plurality of service level agreements is to be considered. In this embodiment, the SLA monitor module **100** presents the user with an option to show violated service level agreements or to show all service level agreements pre-stored in the main memory **36** or temporary memory **72**. The SLA monitor module **100** may be defaulted to show violated service level agreements as shown in Figure **14**. The representation also causes the display of an eight field list including a service field **192** for identifying the network service covered by the service level agreement, a location field **194** identifying the specific VPN termination equipment governed by the service level agreement, a metric field **196** showing the particular service level agreement metric that has been violated, when applicable, an agreed field **197** for indicating an agreed level of the metric, a delivered field **198** showing the current status of the SLA metric in the metric field, when applicable, a penalty field **200** showing the relevant penalty for violation of the service level agreement, an impacting field **202** for showing the applications being affected by the service level agreement violation, when applicable, and finally, a terms of agreement field **204** which shows the date the SLA agreement went into effect.

The terms of agreement field **204** is hyperlinked to an electronic summary of the SLA agreement details, an example of a display of such summary being shown at **210** in Figure **15**. In this embodiment, the detailed summary includes a list of the metrics that are monitored by the SLA monitor module **100**, wherein each metric is listed in association with the SLA threshold level and the penalty associated with violating that threshold level. When a violation occurs, the relevant list item is highlighted in the SLA details list, in addition to the notification provided in the SLA monitor.

Referring back to Figure **4**, it will be appreciated that through the use of the navigation module, the user can select any number of a plurality of applications for producing information to appear in the data portion **82** of the display produced by the composite representation. At the same time, the user is presented with a pictorial representation of the virtual private network which provides the user with an easily understandable representation. The present invention provides carriers or internet services providers with the means to provide a customer-oriented unified virtual private network management solution to most of their enterprise VPN customers in a low cost manner.

In an alternative embodiment, the computer shown in Figure **2** may be located on the premises of the carrier and may include a web server for providing HTML files, for example, as representations for producing the graphical displays described above at remote sites such as any, some, or each of the termination equipment **12-22** at the customer's premises. This simplifies the computer system requirements at the customer's premises and can be offered by the carrier or ISP, for example, as a subscription service providing the user access to information in a predefined format.

While specific embodiments of the invention have been described and illustrated, such embodiments should be considered illustrative of the invention only and not as limiting the invention as construed in accordance with the accompanying claims.

THE EMBODIMENT OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS::

1. A method of providing information about the performance of a communications network, the method comprising:

   a) producing a graphical representation for producing a pictorial representation of said communications network;

   b) receiving data relating to said network;

   c) producing a data representation for displaying at least some of said data; and

   d) producing a composite representation including said graphical representation and said data representation to enable simultaneous display of said pictorial representation and said at least some of said data.

2. The method as claimed in claim 1, further comprising simultaneously displaying said pictorial representation and said at least some of said data, in response to said composite representation.

3. The method as claimed in claim 1 wherein producing said composite representation comprises producing said composite representation to cause said pictorial representation and said at least some of said data to be separated from each other when displayed.

4. The method as claimed in claim 1 further comprising executing a network performance evaluating application to produce said data representation.

5. The method as claimed in claim 4 further comprising producing a representation of a menu of available performance evaluating applications, including said representation of said menu in said

composite representation and invoking at least one of said available performance evaluating applications in response to user input.

6. The method as claimed in claim **5** wherein producing said representation of said menu comprises producing said representation of said menu such that said composite representation causes said menu to be separated from both said pictorial representation and said at least some of said data when displayed.

7. The method as claimed in claim **1** wherein receiving data further comprises operating a data server to obtain said data from a plurality of network components in said network.

8. The method as claimed in claim **4**, wherein executing said network performance evaluating application further comprises producing a representation of a problem notification representing a problem with said network, in response to data indicating a problem and including said representation of said problem notification in said composite representation.

9. The method as claimed in claim **8** further comprising displaying said problem notification in response to said representation thereof, on said pictorial representation.

10. The method as claimed in claim **9** further comprising changing a display attribute of a component associated with said problem and represented in said pictorial representation, to cause said problem notification to be displayed.

11. The method as claimed in claim **10** wherein changing a display attribute further comprises representing at least part of said component with a color different from a color used to represent components of said network not associated with said problem.

12. The method as claimed in claim 8 further comprising including in said composite representation a representation of an icon for association with a problematic component of said network to indicate that more information about said problem is available.

13. The method as claimed in claim 12 further comprising invoking at least one of said performance evaluating applications in response to user input received in association with said icon to include in said composite representation further information about said problem.

14. The method as claimed in claim 12 further comprising accessing a database in response to user input received in association with said icon, to obtain data relating to the impact of said problem on said network and including said data relating to said impact in said composite representation.

15. The method as claimed in claim 14 wherein accessing said database further comprises obtaining data relating to a potential solution to said problem.

16. The method as claimed in claim 4 wherein executing further comprises executing a performance evaluating application for producing a representation for causing display of real time performance of at least one component of said network.

17. The method as claimed in claim 4 wherein executing further comprises executing a performance evaluating application for producing a representation for causing display of historical performance of at least one component of said network and including said representation for causing display of historical performance in said composite representation.

18. The method as claimed in claim 17 wherein executing further comprises receiving user input for querying for data relating to at least

one performance metric of said network, producing a representation for causing display of said data relating to said at least one performance metric in response to said user input and including said representation for causing display of said data relating to said at least one performance metric in said composite representation.

19. The method as claimed in claim **17** wherein executing further comprises receiving user input for querying for data relating to at least one service running on said network, producing a representation for causing display of said data relating to said at least one service in response to said user input and including said representation for causing display of said data relating to said at least one service in said composite representation.

20. The method as claimed in claim **17** wherein executing further comprises receiving user input for querying for data relating to at least one application running on said network, producing a representation for causing display of said data relating to said at least one application and including said representation for causing display of said data relating to said at least one application in said composite representation.

21. The method as claimed in claim **4** wherein executing further comprises executing a rules-based performance analysis expert system for correlating network performance data and for producing a representation for displaying said correlated network performance data and including said representation for displaying said correlated network performance data in said composite representation.

22. The method as claimed in claim **4** wherein executing further comprises determining bandwidth allocation associated with at least one application running on said network, producing a representation of said bandwidth allocation for causing display of said bandwidth allocation and including said representation of said bandwidth allocation in said composite representation.

23. The method as claimed in claim **4** wherein executing further comprises determining bandwidth allocation associated with a plurality of applications running to/from termination equipment on said network, producing a representation for graphically displaying said bandwidth allocation and including said representation for graphically displaying in said composite representation.

24. The method as claimed in claim **23** wherein executing further comprises producing said representation for graphically displaying said bandwidth allocation to cause reference and observed bandwidth allocation to be graphically displayed.

25. The method as claimed in claim **4** wherein executing further comprises monitoring network events, producing a representation for causing display of at least one monitored network event and including said representation for causing display in said composite representation.

26. The method as claimed in claim **25** further comprising signaling a user when a monitored network event has occurred.

27. The method as claimed in claim **4**, wherein executing further comprises determining service level performance metrics, comparing said service level performance metrics to predefined service level performance requirements, producing a representation for causing display of an indication of service level performance metrics which do not meet said predefined service level performance requirements and including said representation for causing display in said composite representation.

28. The method as claimed in claim **27** further comprising producing said representation for causing display of said indication of service level performance metrics such that a predefined penalty associated with failure to meet said predefined service level performance requirements is displayed in association with said indication of service level

performance metrics which do not meet said predefined service level performance requirements.

29. An apparatus for providing information about the performance of a communications network, the apparatus comprising:

a) memory for storing a pictorial representation of said communications network;

b) a receiver for receiving data relating to said network; and

c) a processor for producing a composite representation including a graphical representation of said pictorial representation and a data representation for displaying at least some of said data relating to said network, for use by a device to simultaneously display said pictorial representation and said at least some of said data.

30. The apparatus as claimed in claim **29**, further comprising a display controlled by said processor, for displaying said pictorial representation and said at least some of said data in response to said composite representation.

31. The apparatus as claimed in claim **29** further comprising a transmitter for transmitting said composite representation to a remote device operable to display said pictorial representation and said at least some of said data in response to said composite representation.

32. The apparatus as claimed in claim **29** wherein said processor is programmed to produce said composite representation such that said pictorial representation and said at least some of said data are separated from each other.

33. The apparatus as claimed in claim **29** wherein said processor is programmed to execute a network performance evaluating application to produce said data representation.

34. The apparatus as claimed in claim **33** further comprising a user input device in communication with said processor and wherein said processor is programmed to produce a menu of available performance evaluating applications and to invoke at least one of said available performance evaluating applications in response to user input received at said user input device.

35. The apparatus as claimed in claim **34** wherein said processor is programmed to produce said composite representation such that said composite representation further comprises said menu and such that said menu will be displayed separated from both said pictorial representation and said at least some of said data.

36. The apparatus as claimed in claim **29** wherein said receiver further comprises a data server operable to obtain said data relating to said network from a plurality of network components in said network.

37. The apparatus as claimed in claim **29**, wherein said processor is programmed to determine whether or not data received at said receiver indicates that there is a problem with a network component and if so, to include in said composite representation a problem notification.

38. The apparatus as claimed in claim **37** wherein said processor is programmed to cause said composite representation to be produced such that said problem notification will be displayed on said pictorial representation.

39. The apparatus as claimed in claim **38** wherein said processor is programmed to set display attributes for components represented by said pictorial representation and to change a display attribute of a

component associated with said problem and represented in said pictorial representation, to provide said problem notification.

40. The apparatus as claimed in claim **39** wherein said processor is programmed to represent components of said network in color and to produce said composite representation such that at least part of said component associated with said problem is shown in a color different from a color used to represent components of said network not associated with said problem.

41. The apparatus as claimed in claim **37** wherein said processor is programmed to produce said composite representation to cause an icon to be displayed in association with a problematic component of said network.

42. The apparatus as claimed in claim **41** further comprising a user input device and wherein said processor is programmed to invoke at least one performance evaluating application in response to user input received at said user input device in association with said icon to include in said composite representation further information about said problem, for display.

43. The apparatus as claimed in claim **42** wherein said processor is programmed to access a database in response to user input received in association with said icon, to obtain data relating to the impact of said problem on said network and to display said data relating to said impact.

44. The apparatus as claimed in claim **43** wherein said processor is programmed to obtain data relating to a potential solution to said problem.

45. The apparatus as claimed in claim **33** wherein said processor is programmed to execute a performance evaluating application for

producing said data representation such that it causes real time performance data of at least one component of said network to be displayed.

46. The apparatus as claimed in claim **33** wherein said processor is programmed to execute a performance evaluating application for producing said data representation such that it causes historical performance of at least one component of said network to be displayed.

47. The apparatus as claimed in claim **46** further comprising a user input device and wherein said processor is programmed to receive user input from said user input device, to query for data relating to at least one performance metric of said network and to include in said composite representation a representation for displaying said data relating to said at least one performance metric.

48. The apparatus as claimed in claim **46** further comprising a user input device and wherein said processor is programmed to receive user input from said user input device, to query for data relating to at least one service running on said network and to include in said composite representation a representation for displaying said data relating to said at least one service.

49. The apparatus as claimed in claim **46** further comprising a user input device and wherein said processor is programmed to receive user input from said user input device, to query for data relating to at least one application running on said network, and to include in said composite representation said data relating to said at least one application.

50. The apparatus as claimed in claim **33** wherein said processor is programmed to execute a rules-based performance analysis expert system for correlating network performance data and programmed to

include in said composite representation a representation for displaying said correlated network performance data.

51. The apparatus as claimed in claim **33** wherein said processor is programmed to determine bandwidth allocation associated with at least one application running to/from a termination equipment on said network and to include in said composite representation a representation of said bandwidth allocation, for display.

52. The apparatus as claimed in claim **33** wherein said processor is programmed to determine bandwidth allocation associated with each of a plurality of applications running on said network and to include in said composite representation a representation for graphically displaying said bandwidth allocation.

53. The apparatus as claimed in claim **52** wherein said processor is programmed to produce said representation for graphically displaying such that predicted and actual bandwidth allocation are graphically displayed.

54. The apparatus as claimed in claim **33** wherein said processor is programmed to monitor network events and to include in said composite representation a representation for displaying at least one monitored network event.

55. The apparatus as claimed in claim **54** further comprising a transmitter for transmitting a signal to a user when a monitored network event has occurred.

56. The apparatus as claimed in claim **33**, wherein said processor is programmed to determine service level performance metrics, to compare said service level performance metrics to predefined service level performance requirements and to include in said composite representation a representation for displaying an indication of service

level performance metrics which do not meet said predefined service level performance requirements.

57. The apparatus as claimed in claim 56 wherein said processor is programmed to include in said composite representation a representation causing a predefined penalty associated with failure to meet said predefined service level performance requirements to be displayed in association with said indication of service level performance metrics which do not meet said predefined service level performance requirements.

58. A computer readable medium for providing instruction codes executable by a programmable device, for directing said programmable device to:

a) produce a graphical representation for producing a pictorial representation of a communications network;

b) receive data relating to said network;

c) produce a data representation for displaying at least some of said data; and

d) produce a composite representation including said graphical representation and said data representation to enable simultaneous display of said pictorial representation and said at least some of said data.

59. A computer data signal embodied in a carrier wave, the signal comprising respective code segments for directing a programmable device to:

a) produce a graphical representation for producing a pictorial representation of a communications network;

b) receive data relating to said network;

c) produce a data representation for displaying at least some of said data; and

d) produce a composite representation including said graphical representation and said data representation to enable simultaneous display of said pictorial representation and said at least some of said data.

60. A graphical user interface for use in analyzing a communications network, comprising:

a) receiving means for receiving data relating to said network; and

b) display means for simultaneously displaying a pictorial representation of said network in a first area of a display and a representation of at least some of said data relating to said network in a second area of a display, said first and second areas being separate from each other.

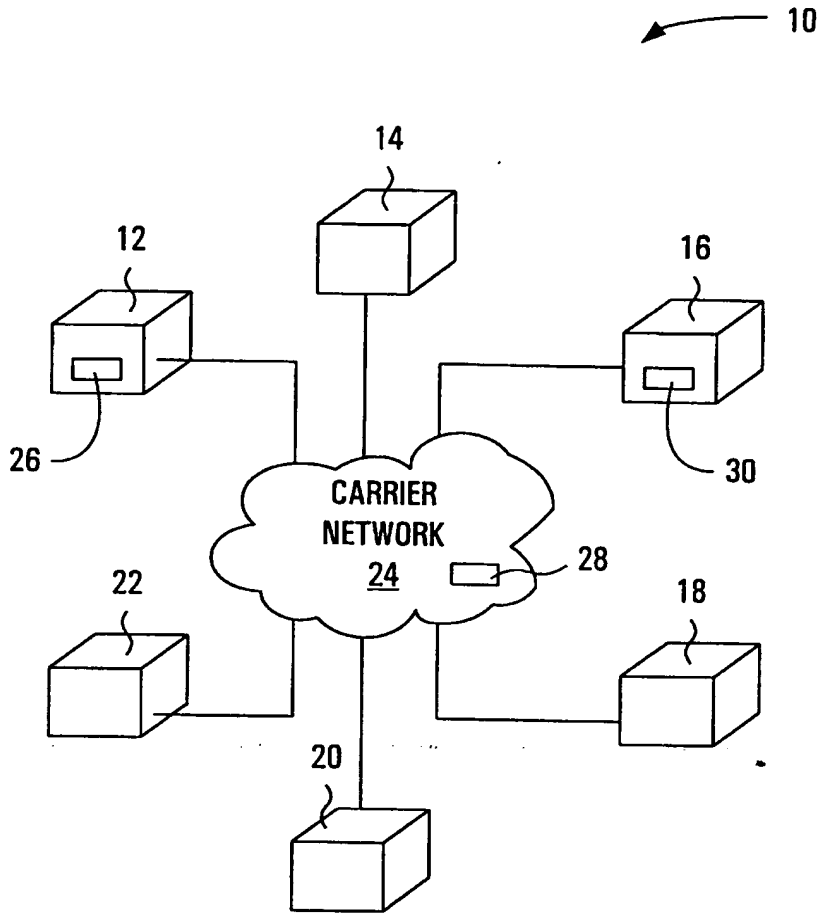


FIG. 1

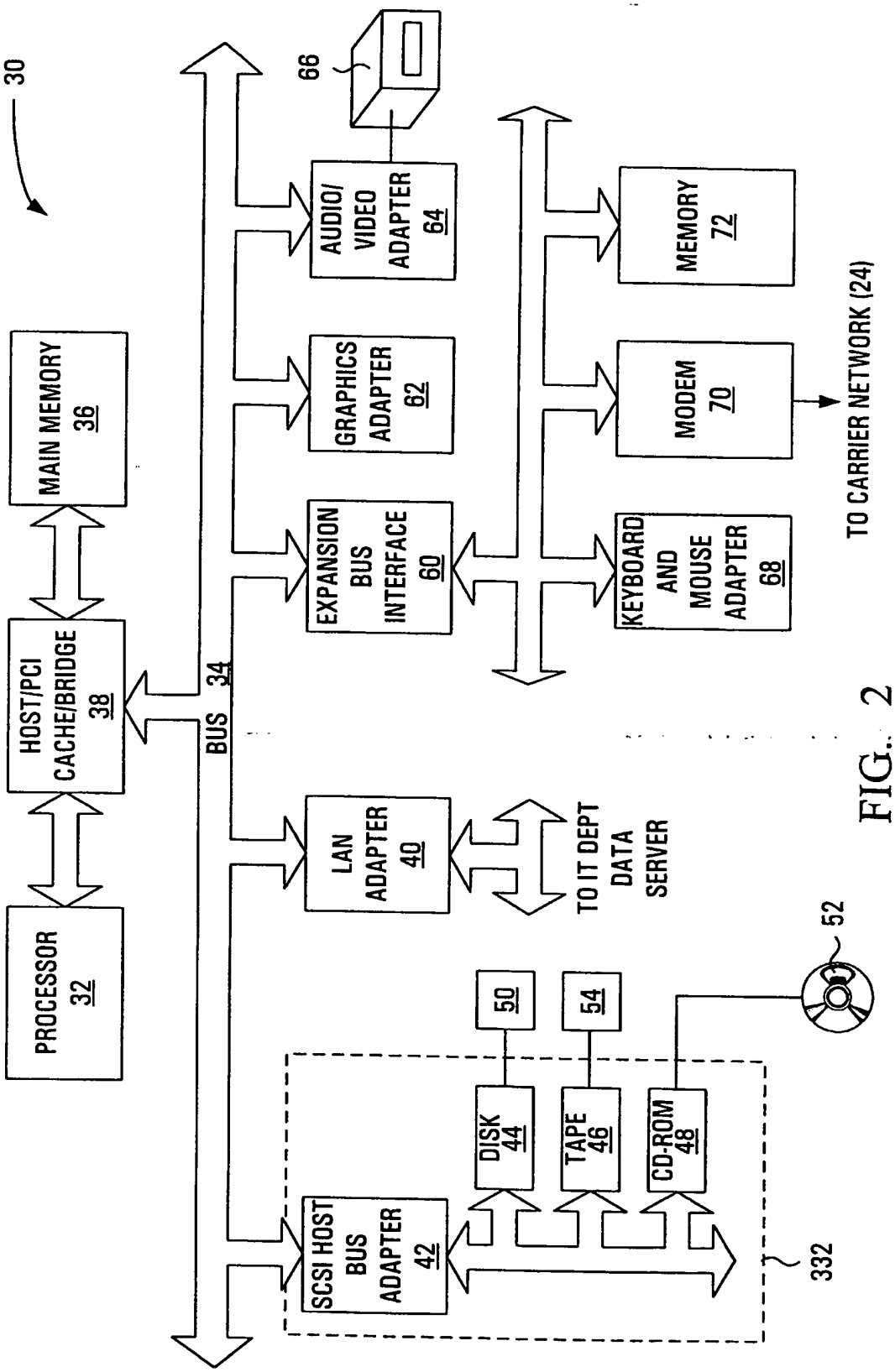

30
66
AUDIO/ VIDEO ADAPTER 64
MEMORY 72
MAIN MEMORY 36
GRAPHICS ADAPTER 62
MODEM 70
TO CARRIER NETWORK (24)
EXPANSION BUS INTERFACE 60
KEYBOARD AND MOUSE ADAPTER 68
HOST/PCI CACHE/BRIDGE 38
BUS 34
LAN ADAPTER 40
TO IT DEPT DATA SERVER
PROCESSOR 32
52
50
54
DISK 44
TAPE 46
CD-ROM 48
SCSI HOST BUS ADAPTER 42
332

FIG. 2

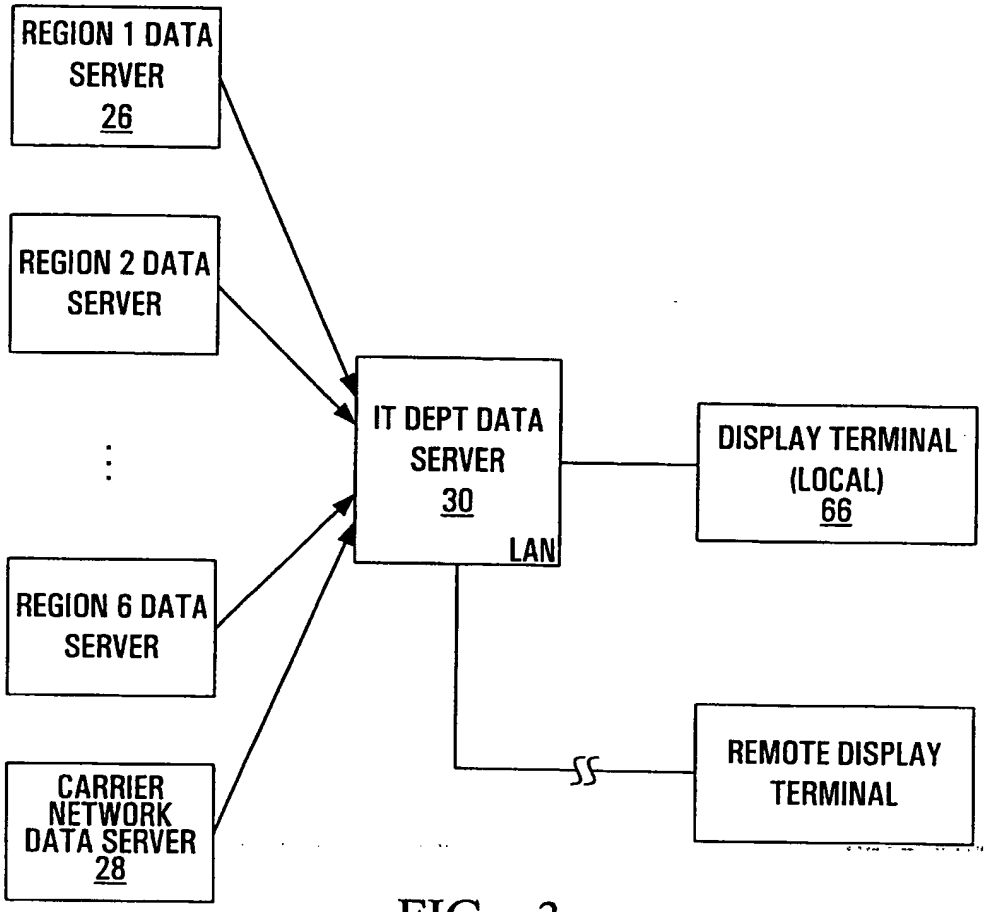

REGION 1 DATA SERVER 26
REGION 2 DATA SERVER
REGION 6 DATA SERVER
CARRIER NETWORK DATA SERVER 28
IT DEPT DATA SERVER 30
LAN
DISPLAY TERMINAL (LOCAL) 66
REMOTE DISPLAY TERMINAL

FIG. 3

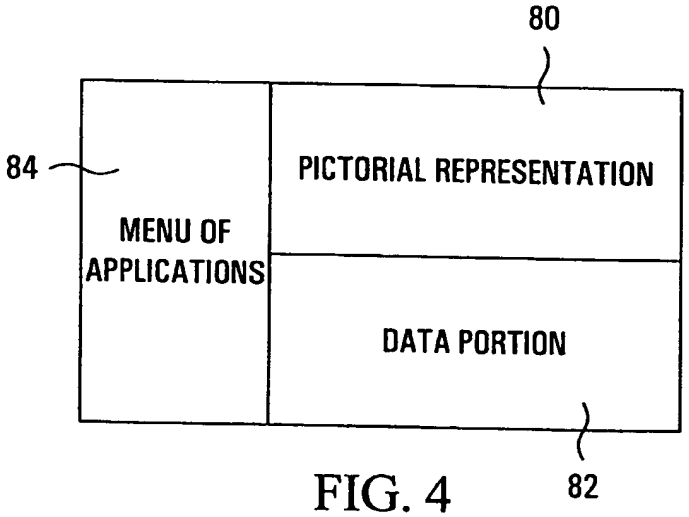

80
84
MENU OF APPLICATIONS
PICTORIAL REPRESENTATION
DATA PORTION
82

FIG. 4

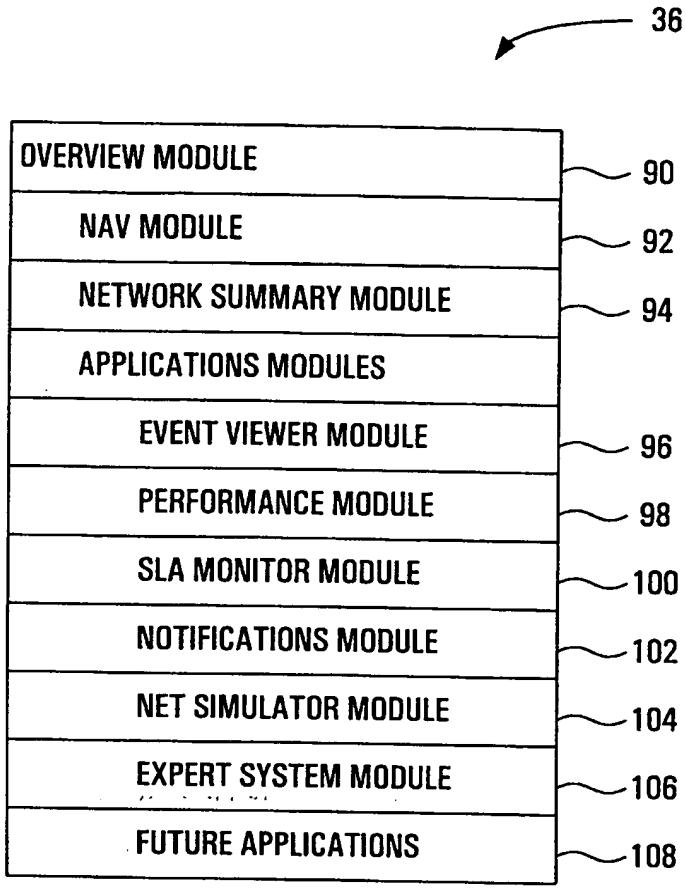

36
OVERVIEW MODULE
90
NAV MODULE
92
NETWORK SUMMARY MODULE
94
APPLICATIONS MODULES
EVENT VIEWER MODULE
96
PERFORMANCE MODULE
98
SLA MONITOR MODULE
100
NOTIFICATIONS MODULE
102
NET SIMULATOR MODULE
104
EXPERT SYSTEM MODULE
106
FUTURE APPLICATIONS
108

FIG. 5

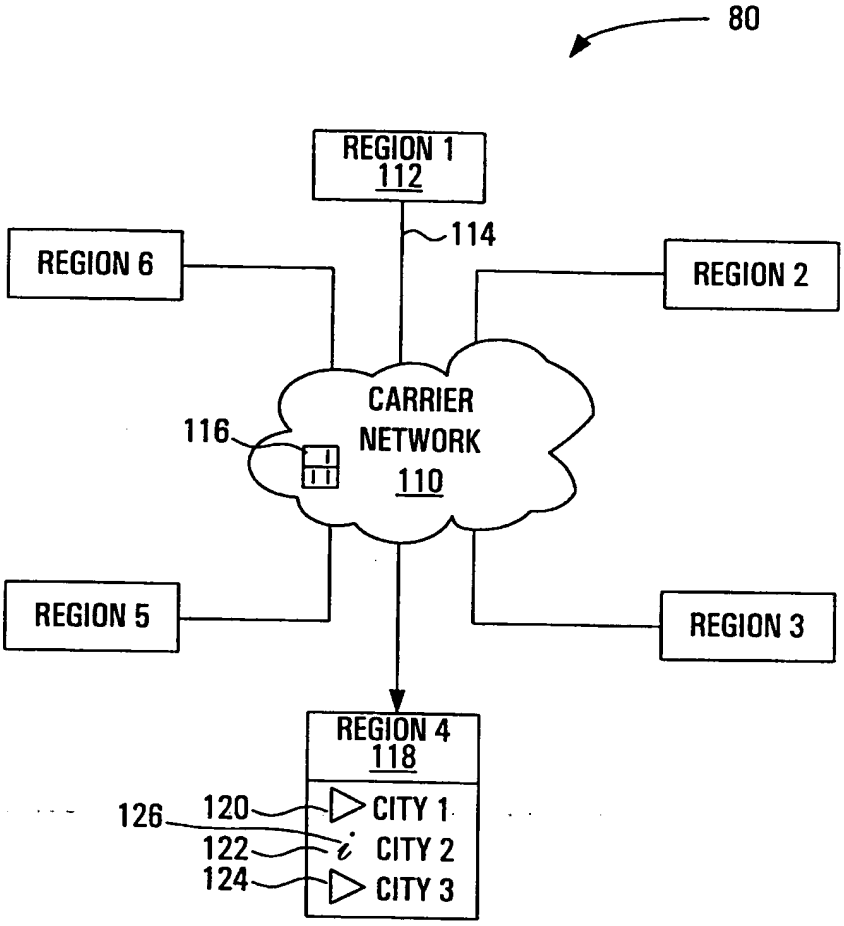

80
REGION 1
112
114
REGION 6
REGION 2
CARRIER
NETWORK
110
116
REGION 5
REGION 3
REGION 4
118
126
120
CITY 1
122
CITY 2
124
CITY 3

FIG. 6

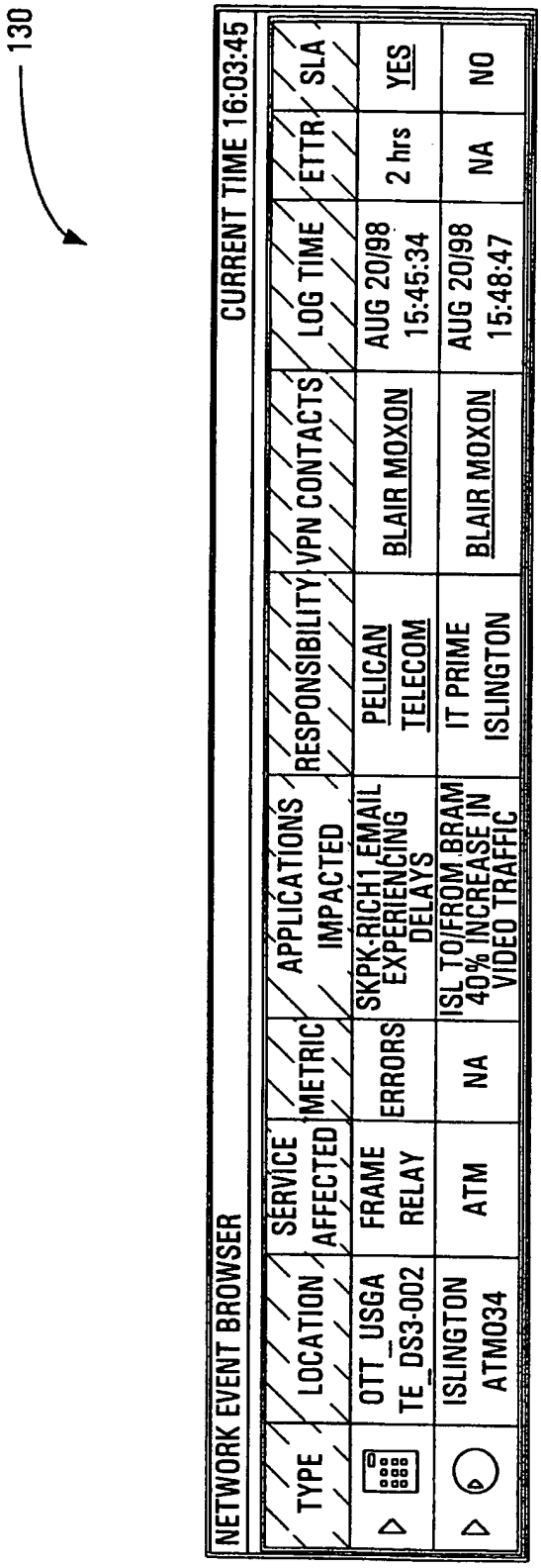

130
NETWORK EVENT BROWSER
CURRENT TIME 16:03:45
TYPE
LOCATION
SERVICE AFFECTED
METRIC
APPLICATIONS IMPACTED
RESPONSIBILITY
VPN CONTACTS
LOG TIME
ETTR
SLA
OTT_USGA TE_DS3-002
FRAME RELAY
ERRORS
SKPK-RICH1 EMAIL EXPERIENCING DELAYS
PELICAN TELECOM
BLAIR MOXON
AUG 20/98 15:45:34
2 hrs
YES
ISLINGTON ATM034
ATM
NA
ISL TO/FROM BRAM 40% INCREASE IN VIDEO TRAFFIC
IT PRIME ISLINGTON
BLAIR MOXON
AUG 20/98 15:48:47
NA
NO

FIG. 7

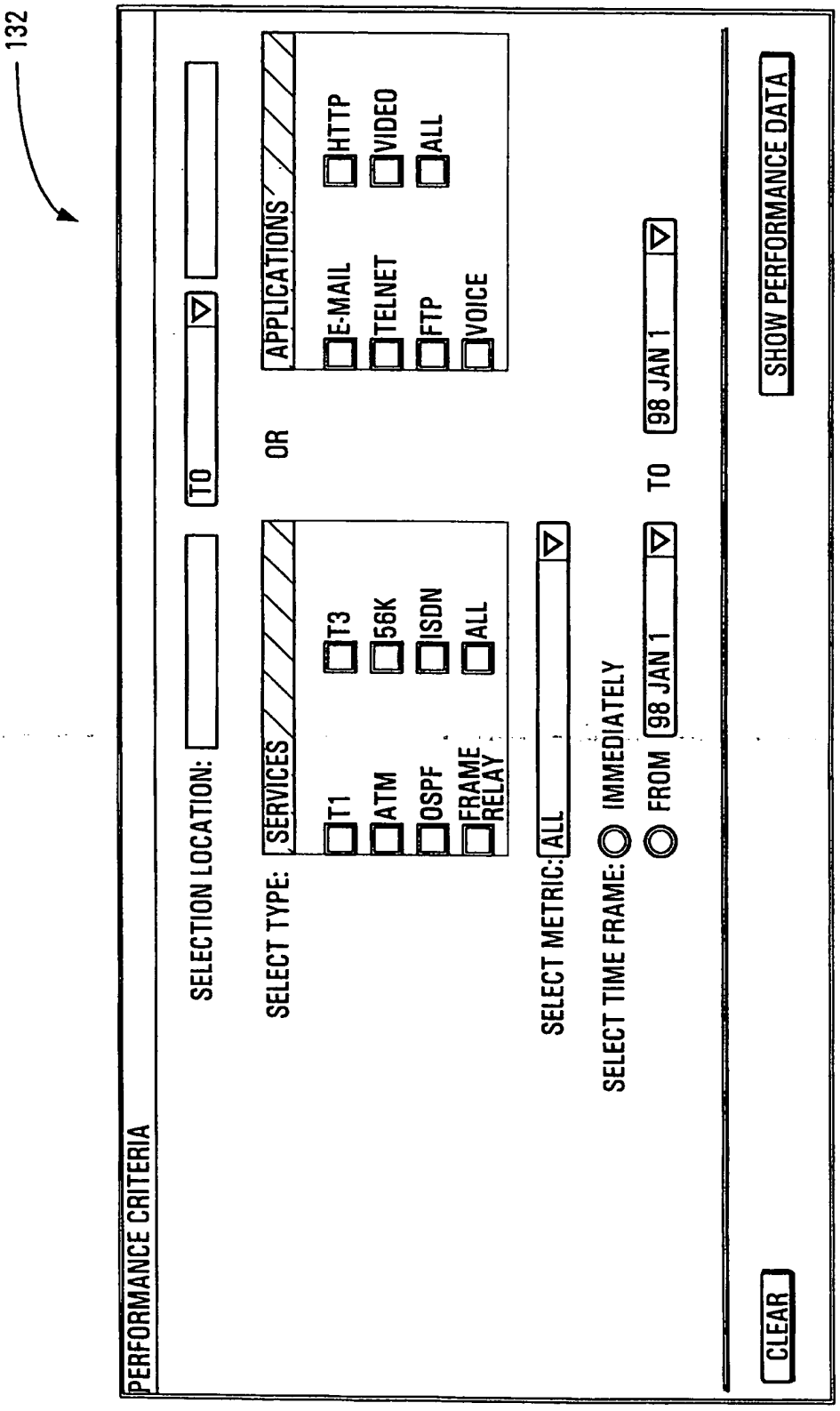

132
PERFORMANCE CRITERIA
SELECTION LOCATION:
TO
SELECT TYPE:
SERVICES
T1
T3
ATM
56K
OSPF
ISDN
FRAME RELAY
ALL
OR
APPLICATIONS
E-MAIL
HTTP
TELNET
VIDEO
FTP
ALL
VOICE
SELECT METRIC:
ALL
SELECT TIME FRAME:
IMMEDIATELY
FROM
98 JAN 1
TO
98 JAN 1
CLEAR
SHOW PERFORMANCE DATA

FIG. 8

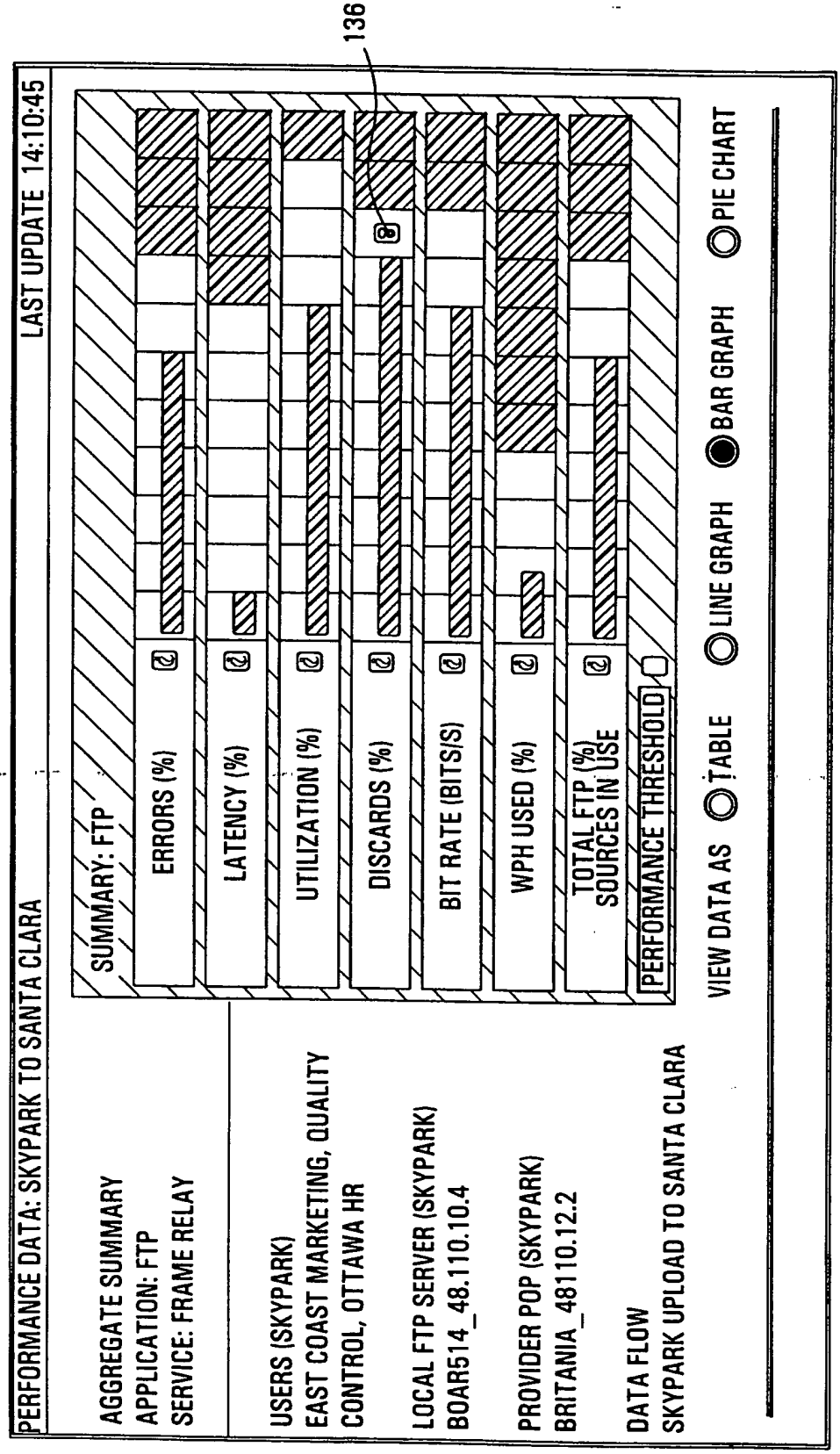

134
136
PERFORMANCE DATA: SKYPARK TO SANTA CLARA
LAST UPDATE 14:10:45
AGGREGATE SUMMARY
APPLICATION: FTP
SERVICE: FRAME RELAY
USERS (SKYPARK)
EAST COAST MARKETING, QUALITY CONTROL, OTTAWA HR
LOCAL FTP SERVER (SKYPARK)
BOAR514_48.110.10.4
PROVIDER POP (SKYPARK)
BRITANIA_48110.12.2
DATA FLOW
SKYPARK UPLOAD TO SANTA CLARA
SUMMARY: FTP
ERRORS (%)
LATENCY (%)
UTILIZATION (%)
DISCARDS (%)
BIT RATE (BITS/S)
WPH USED (%)
TOTAL FTP SOURCES IN USE (%)
PERFORMANCE THRESHOLD
VIEW DATA AS
TABLE
LINE GRAPH
BAR GRAPH
PIE CHART

FIG. 9

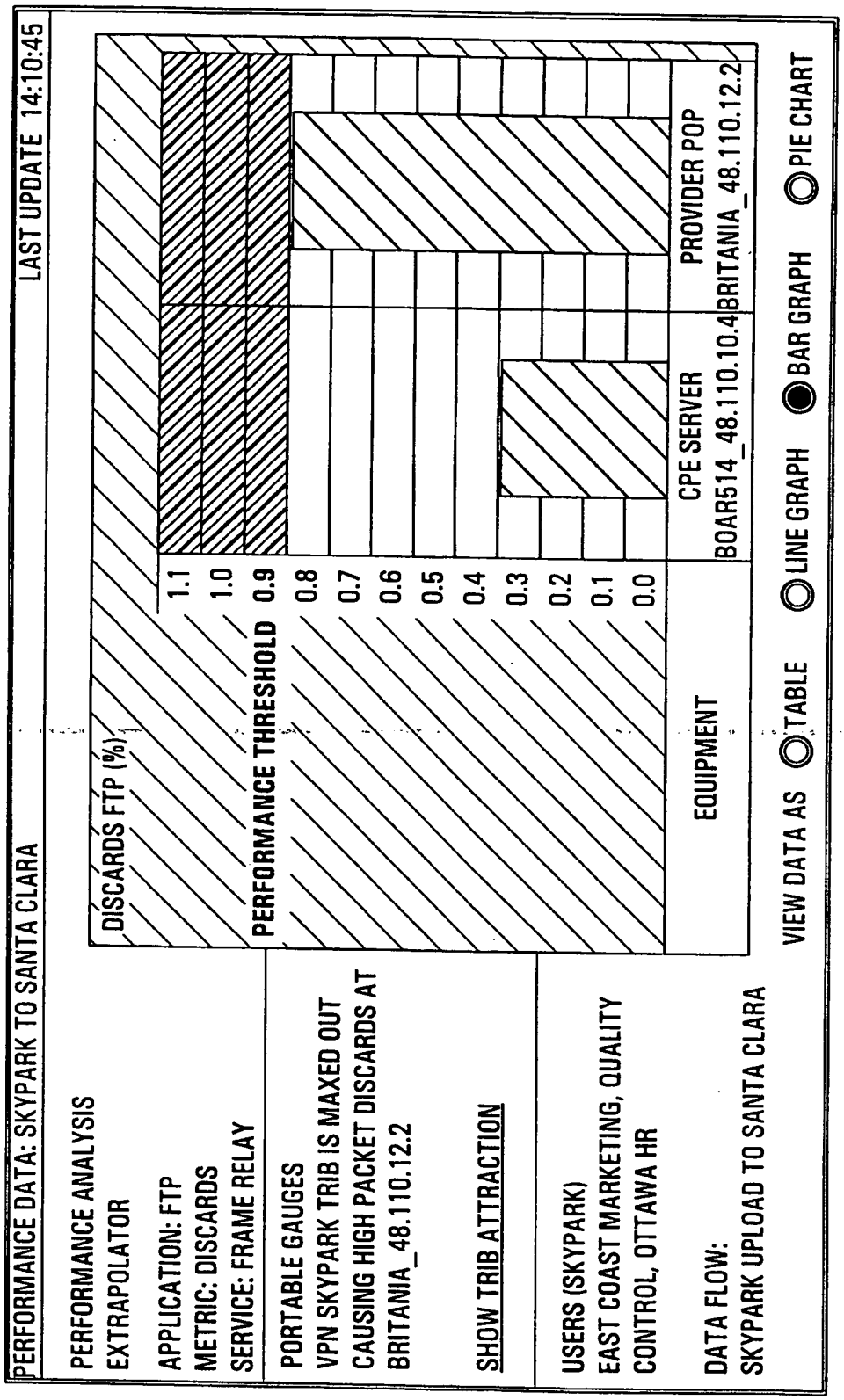

138
PERFORMANCE DATA: SKYPARK TO SANTA CLARA
LAST UPDATE 14:10:45
PERFORMANCE ANALYSIS
EXTRAPOLATOR
APPLICATION: FTP
METRIC: DISCARDS
SERVICE: FRAME RELAY
PORTABLE GAUGES
VPN SKYPARK TRIB IS MAXED OUT
CAUSING HIGH PACKET DISCARDS AT
BRITANIA_48.110.12.2
SHOW TRIB ATTRACTION
USERS (SKYPARK)
EAST COAST MARKETING, QUALITY
CONTROL, OTTAWA HR
DATA FLOW:
SKYPARK UPLOAD TO SANTA CLARA
DISCARDS FTP (%)
1.1
1.0
PERFORMANCE THRESHOLD 0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
EQUIPMENT
CPE SERVER
BOAR514_48.110.10.4
PROVIDER POP
BRITANIA_48.110.12.2
VIEW DATA AS
TABLE
LINE GRAPH
BAR GRAPH
PIE CHART

FIG. 10

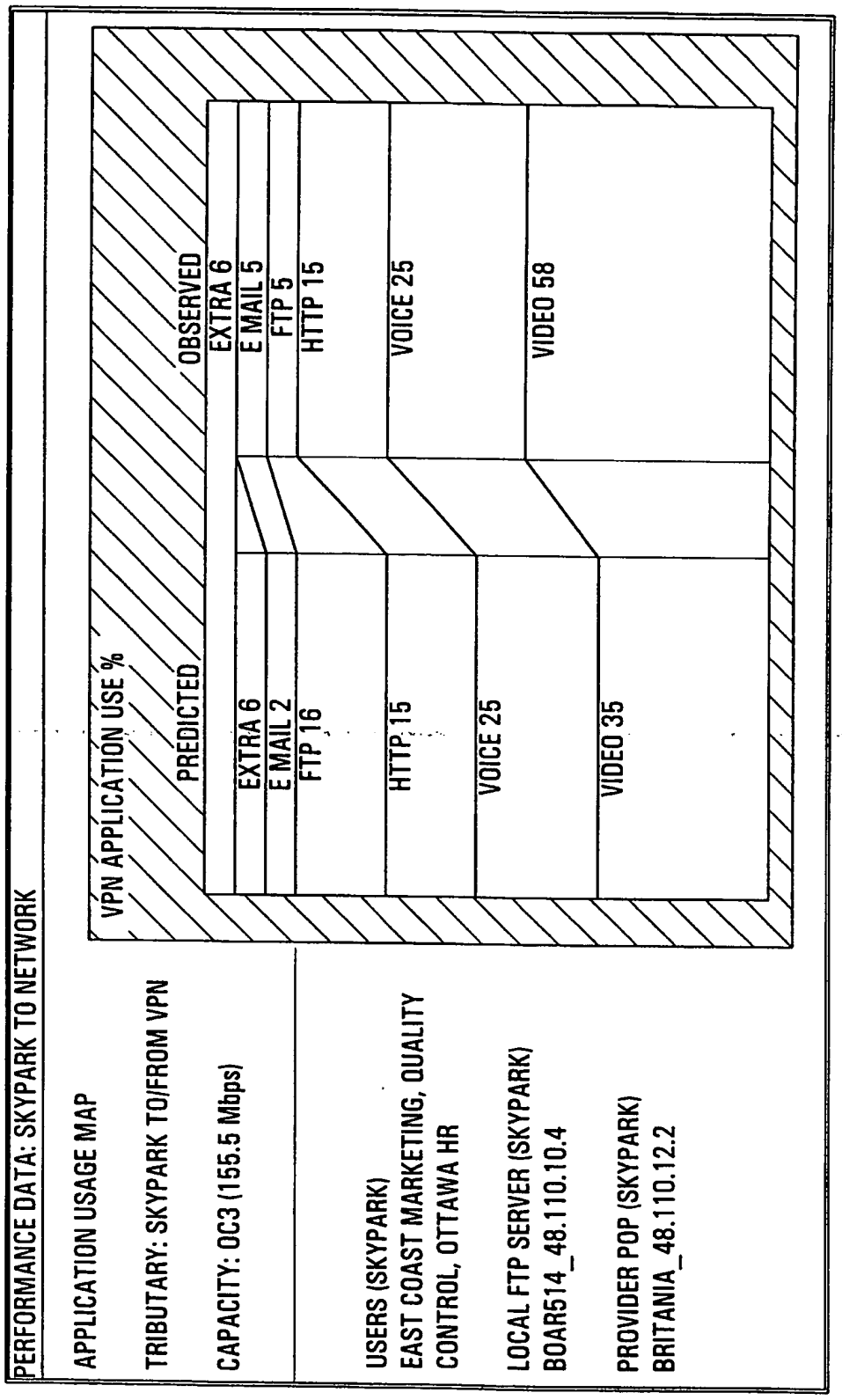

140
PERFORMANCE DATA: SKYPARK TO NETWORK
APPLICATION USAGE MAP
TRIBUTARY: SKYPARK TO/FROM VPN
CAPACITY: OC3 (155.5 Mbps)
USERS (SKYPARK)
EAST COAST MARKETING, QUALITY CONTROL, OTTAWA HR
LOCAL FTP SERVER (SKYPARK)
BOAR514_48.110.10.4
PROVIDER POP (SKYPARK)
BRITANIA_48.110.12.2
VPN APPLICATION USE %
PREDICTED
EXTRA 6
E MAIL 2
FTP 16
HTTP 15
VOICE 25
VIDEO 35
OBSERVED
EXTRA 6
E MAIL 5
FTP 5
HTTP 15
VOICE 25
VIDEO 58

FIG. 11

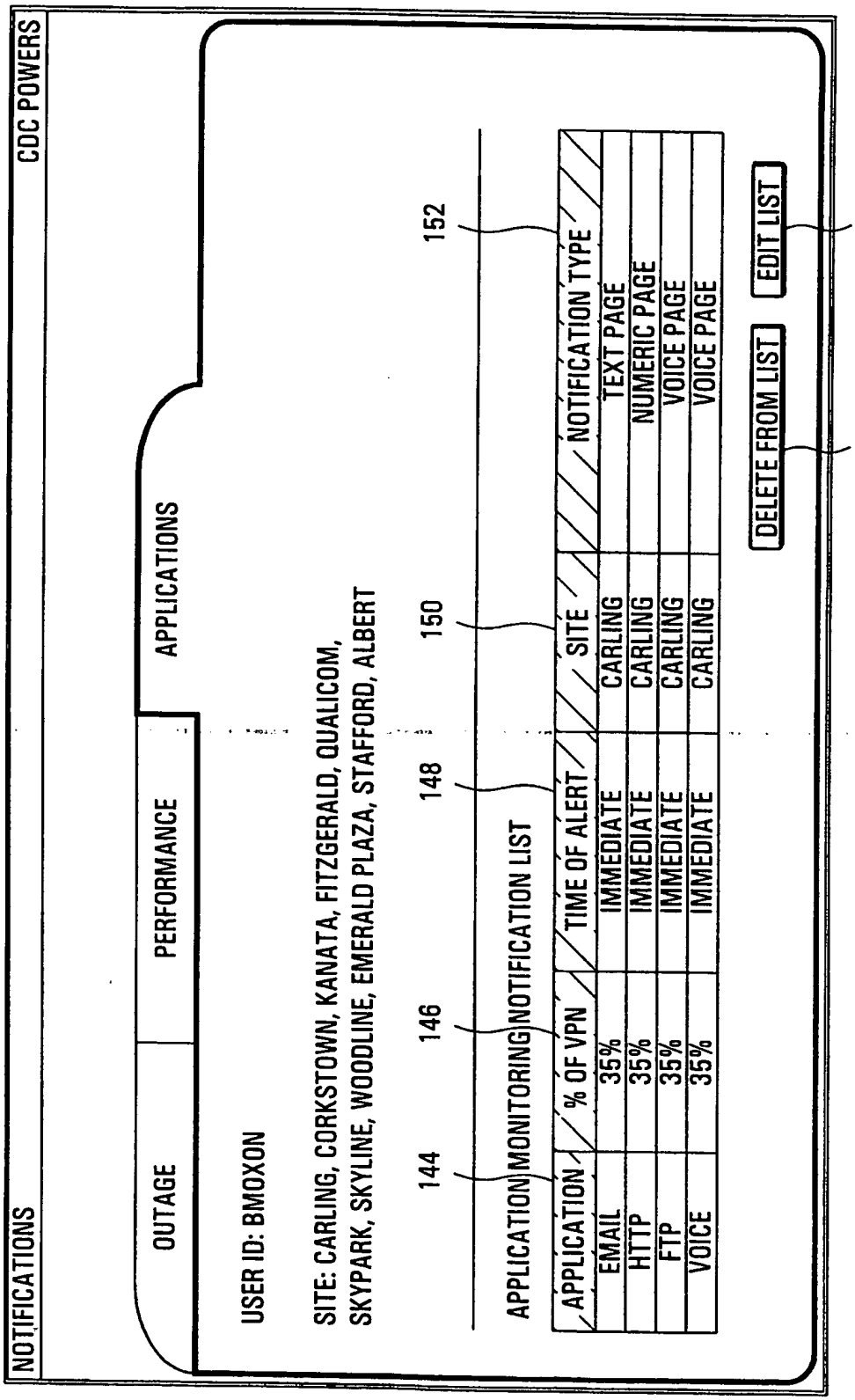
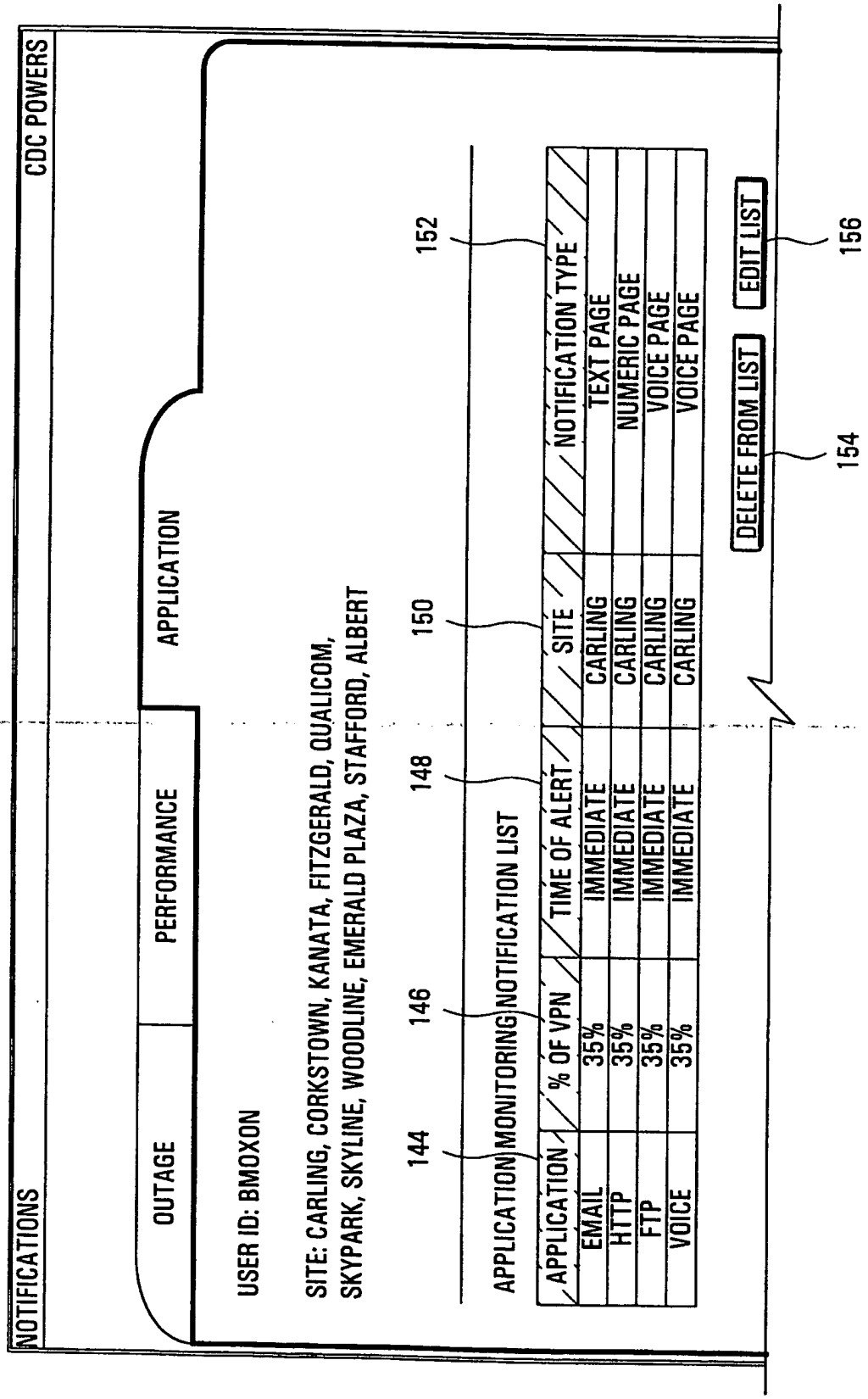

142
NOTIFICATIONS
CDC POWERS
OUTAGE
PERFORMANCE
APPLICATIONS
USER ID: BMOXON
SITE: CARLING, CORKSTOWN, KANATA, FITZGERALD, QUALICOM, SKYPARK, SKYLINE, WOODLINE, EMERALD PLAZA, STAFFORD, ALBERT
144
146
148
150
152
APPLICATION MONITORING NOTIFICATION LIST
APPLICATION
% OF VPN
TIME OF ALERT
SITE
NOTIFICATION TYPE
EMAIL 35% IMMEDIATE CARLING TEXT PAGE
HTTP 35% IMMEDIATE CARLING NUMERIC PAGE
FTP 35% IMMEDIATE CARLING VOICE PAGE
VOICE 35% IMMEDIATE CARLING VOICE PAGE
DELETE FROM LIST
154
EDIT LIST
156

FIG. 12

FIG. 13A


180
NOTIFICATIONS
CDC POWERS
OUTAGE
PERFORMANCE
APPLICATION
USER ID: BMOXON
SITE: CARLING, CORKSTOWN, KANATA, FITZGERALD, QUALICOM, SKYPARK, SKYLINE, WOODLINE, EMERALD PLAZA, STAFFORD, ALBERT
144
146
148
150
152
APPLICATION MONITORING NOTIFICATION LIST
APPLICATION
% OF VPN
TIME OF ALERT
SITE
NOTIFICATION TYPE
EMAIL 35% IMMEDIATE CARLING TEXT PAGE
HTTP 35% IMMEDIATE CARLING NUMERIC PAGE
FTP 35% IMMEDIATE CARLING VOICE PAGE
VOICE 35% IMMEDIATE CARLING VOICE PAGE
DELETE FROM LIST
EDIT LIST
154
156

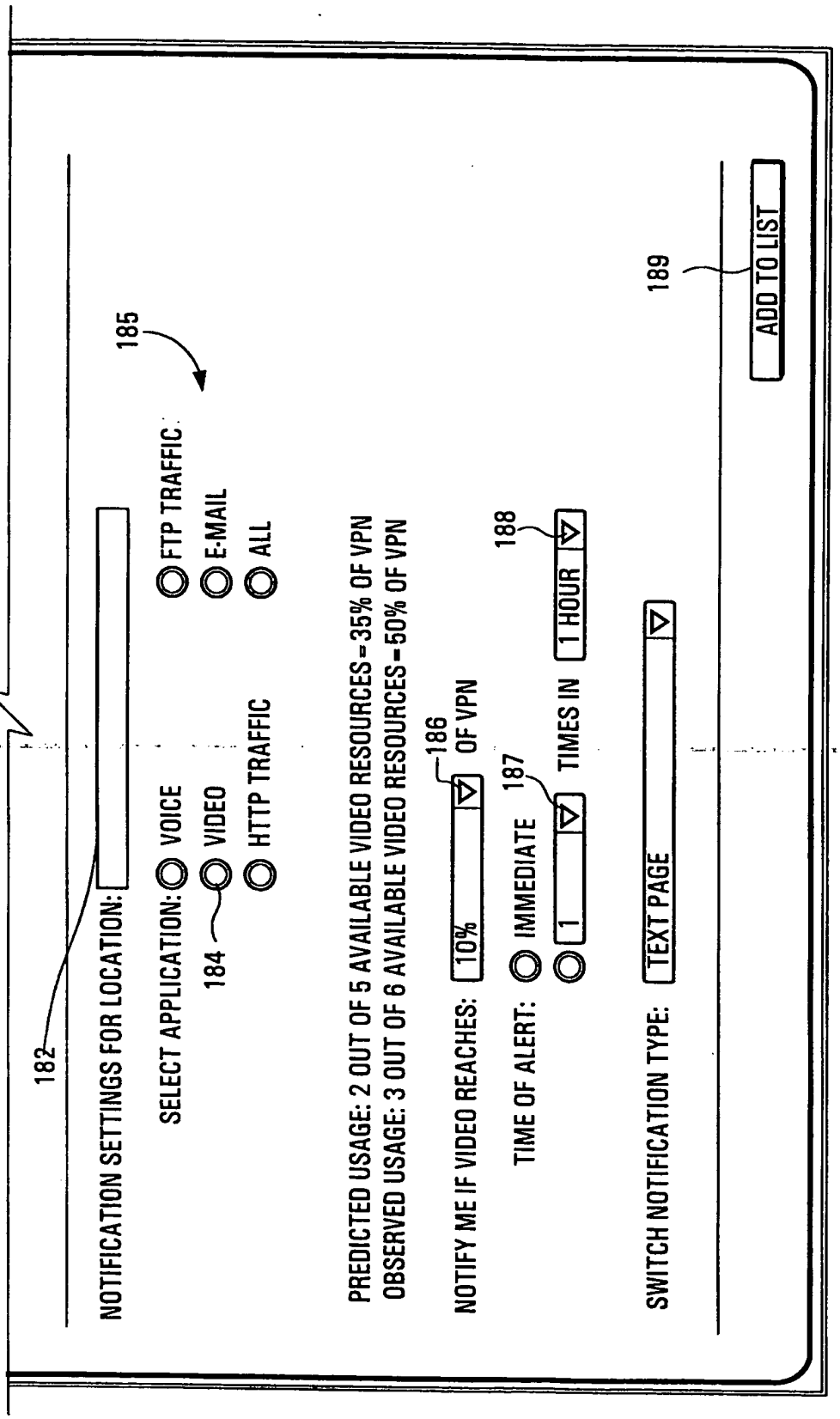

NOTIFICATION SETTINGS FOR LOCATION:
182
SELECT APPLICATION:
VOICE
VIDEO
HTTP TRAFFIC
184
FTP TRAFFIC
E-MAIL
ALL
185
PREDICTED USAGE: 2 OUT OF 5 AVAILABLE VIDEO RESOURCES = 35% OF VPN
OBSERVED USAGE: 3 OUT OF 6 AVAILABLE VIDEO RESOURCES = 50% OF VPN
NOTIFY ME IF VIDEO REACHES:
10%
186
OF VPN
TIME OF ALERT:
IMMEDIATE
1
187
TIMES IN
1 HOUR
188
SWITCH NOTIFICATION TYPE:
TEXT PAGE
189
ADD TO LIST

FIG. 13B

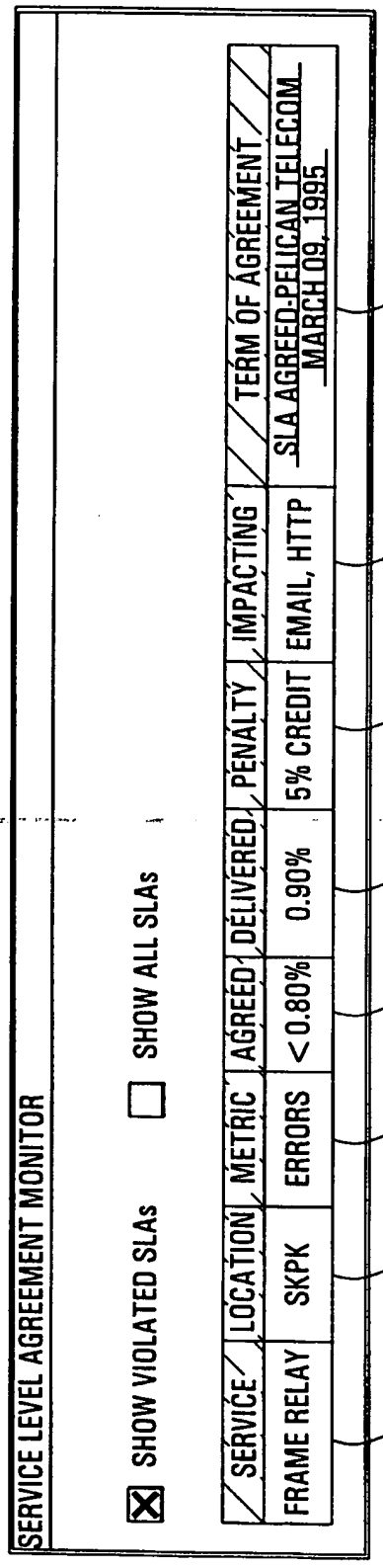
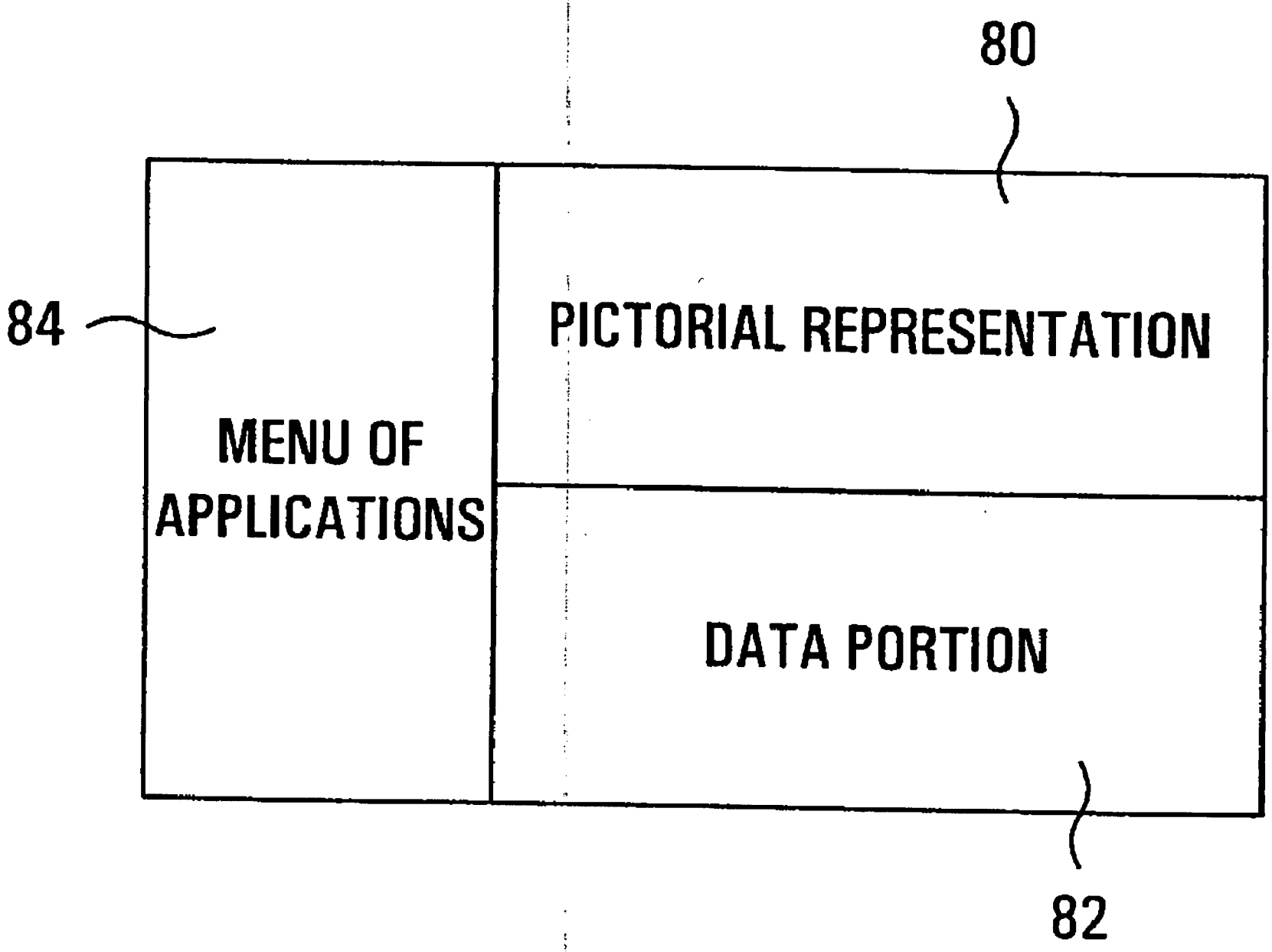

190
SERVICE LEVEL AGREEMENT MONITOR
SHOW VIOLATED SLAs
SHOW ALL SLAs
SERVICE
LOCATION
METRIC
AGREED
DELIVERED
PENALTY
IMPACTING
TERM OF AGREEMENT
FRAME RELAY
SKPK
ERRORS
< 0.80%
0.90%
5% CREDIT
EMAIL, HTTP
SLA AGREED:PELICAN TELECOM MARCH 09, 1995
192
194
196
197
198
200
202
204

FIG. 14

210

SLA DETAILS		AGREED: MARCH 09, 1995
PELICAN TELECOM VPN SERVICE AGREEMENT		
PREPARED FOR GASPAR CORPORATION SERVICE: FRAME RELAY (SKPK TO NETWORK)		
METRIC	SERVICE LEVEL	PENALTY
MEAN TIME TO REPAIR (MTTR)	< 5 HOURS	10% CREDIT
MEAN TIME BETWEEN FAILURES (MTBF)	> 3 DAYS	10% CREDIT
NETWORK AVAILABILITY	99.7%	1 MONTH CREDIT
SERVICE AVAILABILITY	99.5%	1 MONTH CREDIT
DIAL PORT AVAILABILITY	99.5%	1 WEEK CREDIT
END-TO-END LATENCY	< 150ms ROUND-TRIP	1 WEEK CREDIT
ERRORS	< 0.80%	5% CREDIT
PACKET LOSS	< 1%	1 WEEK CREDIT
DISCARDS	< 0.80%	5% CREDIT
NUMBER OF USERS SUPPORTED	500	1 WEEK CREDIT FOR EVERY 10 USERS DROPPED

FIG. 15


80
84
PICTORIAL REPRESENTATION
MENU OF APPLICATIONS
DATA PORTION
82